

TAXONOMIC REVISION OF THE GENUS
MYRIOPHYLLUM (HALORAGACEAE) IN CHINA

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ABSTRACT. A taxonomic treatment of the genus *Myriophyllum* L. (Haloragaceae) from China is presented. The distribution patterns of the species are generalized. Seven species have traditionally been recorded from China: *M. aquaticum*, *M. dicoccum*, *M. humile*, *M. spicatum*, *M. tetrandrum*, *M. ussuriense*, and *M. verticillatum*. Previous identifications of *M. humile* are incorrect and the species that occurs in China is *M. dicoccum*. Specimens previously assigned to “*M. spicatum*” can better be assigned to two distinct taxa, *M. spicatum sensu stricto* and *M. sibiricum*. Newly recorded species are: *M. alterniflorum*, *M. heterophyllum*, *M. oguraense*, *M. sibiricum*, and *M. tuberculatum*. Comments, descriptions, additional notes, specimen citations, distribution, diagnoses, and a key for the Chinese taxa of *Myriophyllum* are provided. The native species of this genus exhibit both strong warm/cool temperate affinities and tropical affinities. Four distribution patterns are generalized as follows: 1. Old World Tropics (3 species), 2. Old World Temperate (1 species), 3. North Temperate (4 species), and 4. East Asia endemics (1 species).

Key Words: *Myriophyllum*, Haloragaceae, China

Myriophyllum L. (Haloragaceae) is almost cosmopolitan. However, the distribution of approximately 60 species has three main centers: Australasia, North America, and India/Indo-China. The highest concentration of species diversity is found in Australasia with 36 species of which 31 are endemic (Orchard 1990). To date seven species have been reported from China (Li and Hsieh 1996; Wan 2000; Yan 1983): *M. aquaticum* (Vell.) Verdc., *M. dicoccum* F. Muell., *M. humile* (Raf.) Morong, *M. spicatum* L., *M. tetran-*

drum Roxb., *M. ussuriense* (Regel) Maxim., and *M. verticillatum* L. The species *M. aquaticum* and *M. dicoccum* were not reported in *Flora Reipublicae Popularis Sinicae* (Wan 2000). The purpose of this contribution is to provide an updated treatment of the genus in China. Through extensive field collections and herbarium studies we have discovered that five additional species occur in China. The discovery of these species necessitates a taxonomic treatment and geographical analysis of the genus within China.

MATERIALS AND METHODS

The present work is based on both extensive field collections and the study of herbarium specimens. We have made over 300 collections throughout China, and vouchers from field collections were deposited in WH. Collections from the following herbaria were studied: CDBI, HAST, HIB, HNR, HNWP, IBK, IBSC, IFP, KUN, N, NAS, NEFI, NTUF, PE, TAI, TAIF, TNM, WH, and WUK (abbreviations for herbaria follow *Index Herbariorum Sinicorum*, Fu 1993).

The distribution data were collected over ten years from field collections throughout China and from herbarium studies. Representative specimens are listed for each species and were selected to illustrate their geographic range in China.

KEY TO CHINESE SPECIES OF *MYRIOPHYLLUM*

1. Emergent leaves pectinate-pinnatifid, never entire nor serrate (2)
 2. Dioecious; turions not developed (only female plants in China) 2. *M. aquaticum*
 2. Monoecious; turions well developed (3)
 3. Floral leaves glaucous or light bluish-green; turions 6–8 cm long 5. *M. oguraense*
 3. Floral leaves green or light to dark green; turions 1–3 cm long 11. *M. verticillatum*
1. Emergent leaves or at least the upper ones undivided, margin entire or serrate (4)
 4. Fruits mainly 2-locular (few 4-locular in bisexual flowers), mericarps smooth or tuberculate on dorsal surface, indistinctly lineolate lengthwise 3. *M. dicoccum*

4. Fruits strictly 4-locular, mericarps aculeate or smooth on dorsal surface (5)
5. Dioecious, fruits up to 0.75 mm long
..... 10. *M. ussuriense*
5. Monoecious, fruits (1-) 1.5-3.5 mm long (6)
 6. Uppermost floral leaves alternate (7)
 7. Stamens 8; fruits subcylindrical in cross section, 1.5-2.0 mm long, mericarps dorsally rounded, mostly smooth or sparsely verrucate
..... 1. *M. alterniflorum*
 7. Stamens 4; fruits quadrangular in cross section, 2.5-3.5 mm long, mericarps dorsally acute or ridged, sparsely tuberculate and aculeate 9. *M. tuberculatum*
 6. Uppermost floral leaves verticillate (8)
 8. Stamens 4; floral leaves much longer than fruits in length (9)
 9. Bracteoles ovate, margin serrate, ca. 1.2 mm long; fruits rounded, longer than broad .. 4. *M. heterophyllum*
 9. Bracteoles palmatifid, lobes subulate, ca. 0.4 mm long; fruits cruciform, as long as broad
..... 8. *M. tetrandrum*
 8. Stamens 8; floral leaves shorter than or rarely equaling fruits in length (10)
 10. Submerged leaves usually with 7-12 pairs of segments; stems below inflorescence almost same as the lower parts in width; bracteoles ovate, longer than broad or of equal proportions; anthers 1.2-1.8 mm long 6. *M. sibiricum*
 10. Submerged leaves usually with 14-24 pairs of segments; stems below inflorescence almost double the lower parts in width; bracteoles reniform to suborbicular, broader than long; anthers 1.8-2.2 mm long ...
..... 7. *M. spicatum*

TAXONOMIC TREATMENT

1. *Myriophyllum alterniflorum* Alph. de Candolle, Fl. Fr. Suppl. 6: 529. 1815. TYPE: FRANCE.

Perennial aquatic herb, monoecious. Stems unbranched or few-branched. Submerged leaves in whorls of (3–) 4–5, occasionally scattered, pinnate, with 8–10 pairs of 0.5–1.5 cm long, and crowded filiform segments. Inflorescence a simple spike, erect, up to 3–7 (–12) cm long, with the unisexual flowers borne in the axils of the floral leaves, upper flowers male, lower flowers female; uppermost male flowers alternate; floral bracts entire or serrate, less than twice the length of the flowers, the uppermost ones ovate or linear, entire or minutely toothed. Stamens 8. Fruits subcylindrical, 1.5–2.0 mm long; mericarps rounded on the back, sparsely verrucate, with a deep groove between them.

Myriophyllum alterniflorum is newly recorded in China. It has an erect spicate inflorescence with upper male flowers alternate. The species morphology varies considerably with its environment. Plants in China sometimes have inflorescences 6–12 cm long compared to 3 cm in European plants. Variation between North American and European forms of this species were also found. Specimens from Newfoundland have short compact leaves, which were identified as var. *americanum* by Pugsley (1938), but the variety is no longer recognized (Aiken 1981). Leaf length in this taxon is a phenotypically plastic characteristic ranging from 0.3–4.0 cm long, and Aiken (1981) noted that plants with short compact leaves are manifestations of low-nutrient environments. Harris et al. (1992) found that genetic variation exists both within and between populations of this species from northwestern Scotland. Plants from northern parts of Europe have robust stems and look like *M. sibiricum* (Aiken 1979; Aiken and McNeill 1980; Ceska and Ceska 1986). *Myriophyllum alterniflorum* and *M. sibiricum* are two distinct taxa, easily distinguished by upper floral bracts alternate and winter turions absent in *M. alterniflorum*, versus all floral bracts whorled and winter turions developed in *M. sibiricum*. The chromosome number in *M. alterniflorum* is $2n = 14$, while $2n = 42$ in *M. sibiricum*. Differences in pollen grains (e.g., wall sculpture microrugulate in *M. alterniflorum* vs. microverrucate in *M. sibiricum*) have also been recorded (Aiken 1978; Faegri 1982).

DISTRIBUTION. Central China (Anhui, Gansu, Hubei, and Jiangsu). *Myriophyllum alterniflorum* is found in the boreal and temperate zones of the Northern Hemisphere. In Europe it is most frequent in the north and west but extends south to Sicily. It is also recorded from North Africa, Russia (Okhotsk and Kamchatka), Greenland, and North America (from Newfoundland to Alaska, south to Nova Scotia, New England, northern New York, northern Michigan, and northern Minnesota).

REPRESENTATIVE SPECIMENS EXAMINED: CHINA. Anhui: Bohu Lake, 14 Sep 1993, *D. Yu* 930937 (WH); Guhe, 18 Sep 1951, *Statio Orientali-Sinensis* 3537 (PE, NAS); Huangda Lake, 14 Sep 1993, *D. Yu* 930925 (WH). Gansu: Wudu, 21 Jul 2000, *D. Wang and Z. Q. Li* 00070006b (WH); 17 Oct 2001, *D. Wang and Y. K. Li* 1079 (WH). Hubei: Baoan Lake, 16 Jul 1994, *D. Yu* 947001 (WH); Liangzi Lake, 25 Aug 1993, *D. Yu* 938124 (WH). Jiangsu: Yixing, no date, *J. Shen* 992 (NAS).

2. *Myriophyllum aquaticum* (Vell.) Verdc., Kew Bull. 28: 36. 1973. Basionym: *Enydria aquatica* Vell., Fl. Flumin. 57. 1825. TYPE: BRAZIL. *J. M. da C. Vellozo*, not seen, probably lost (LECTOTYPE: *J. M. da C. Vellozo*, Fl. Flumin. Icon. 1: t. 150. 1831, designated by A. E. Orchard, Brunonia 2: 249. 1979).

Myriophyllum brasiliense Cambess., Fl. Bras. Merid. 2: 182. 1829. TYPE: BRAZIL. *A. St. Hilaire* 1082 (LECTOTYPE: photograph at MPU, not seen, designated by A. E. Orchard, Brunonia 4: 33. 1980).

Myriophyllum proserpinacoides Gillies ex Hook. et Arn., Bot. Misc. 3: 313. 1833. TYPE: ARGENTINA. "Ditches at Buenos Ayres", *L. Gillies s.n.* (LECTOTYPE: K, designated by A. E. Orchard, Brunonia 2: 249. 1979).

Perennial aquatic or marsh-dwelling herb. Dioecious (male plants absent in China). Stems up to 1 m (or more) long, 4–5 mm in diameter, branched mostly at the base only, glaucous, rooting freely from lower nodes, glabrous. Leaves all whorled, pectinate, densely crowded, slightly dimorphic; leaf bases somewhat dilated. Submerged leaves in whorls of (4–) 5–6, oblanceolate in outline, rounded at apex, 3.2–4.0 cm long, with 25–30 linear pinnae up to 0.7 cm long. Emergent leaves glaucous, in whorls of (4–) 5–6, erect near apex, more or less spreading in lower parts, narrowly oblanceolate in outline, rounded at apex, (1.5–) 2–3.5 cm long, (0.3–) 0.5–0.8 cm wide, with (18–) 24–36 pinnae in the upper part, pinnae linear-subulate, tips very shortly apiculate, slightly incurved. Numerous pale hydathodes present at the

base of leaves. Female flowers 4-merous, with a short pedicel to 0.2–0.5 mm long, borne in the axils of the middle and upper emergent leaves. Bracteoles white, subulate, with somewhat dilated base, sometimes with 1 (–2) lateral lobes, 1.0–1.5 mm long; sepals 4, white, narrowly deltoid, 0.4–0.5 mm long, 0.2–0.3 mm wide, acute, entire or scarcely serrate; petals reduced. Styles 4, clavate, 0.1–0.2 mm long, stigmas white, densely fimbriate. Ovary pyriform, 0.6–0.7 mm long, ca. 0.6 mm wide. Fruits not found. Reproduction in China is strictly vegetative.

Myriophyllum aquaticum is the most commonly cultivated and nearly naturalized species in Taiwan. It was reported by Li and Hsieh in 1996 but the species is not recorded in *Flora Reipublicae Popularis Sinicae* (Wan 2000). Up to the present, only female plants have been found in China. Several characters readily distinguish this taxon from other Asian species: plants dioecious (only females found); emergent leaves glaucous or light bluish-green; all leaves whorled, never entire, and pinnately divided with linear segments; bracteoles subulate with 1 (–2) lateral lobes; and turions not developed. As far as we know, male plants are unknown outside of its native range, and only female plants have become naturalized elsewhere. It is reported that female plants are cultivated and naturalized in warm temperate and tropical areas elsewhere in South America and in Africa, Asia, Australia, New Zealand, Europe, North and Central America, and Hawaii (Cook 1996; Li and Hsieh 1996; Orchard 1990; Preston and Croft 1997). There are no specialized vegetative propagules, and plants spread mainly by asexual means such as detached stem fragments. The species was probably introduced to China by the aquarium trade, either from Japan or from the Atlantic via the Malay Peninsula.

DISTRIBUTION. Taiwan, native to South America (East Brazil, Uruguay, Argentina, and Chile), often cultivated elsewhere in ponds or aquaria, naturalized in Central America, North America, Europe, Africa, Australia, the Pacific (New Zealand and Hawaii), Malay Peninsula, and Japan.

REPRESENTATIVE SPECIMENS EXAMINED: CHINA. Taiwan: Taipei, 19 Jun 1996, Z. Y. Li 11005 (female; PE); Nantou, 2 Jul 1996, Z. Y. Li et al. s.n. (female; PE).

3. *Myriophyllum dicoccum* F. Muell., Trans. & Proc. Philos. Inst.

Victoria. 3: 41. 1859. TYPE: AUSTRALIA. Northern Territory: Robinson River, no date, *F. Mueller s.n.* (HOLOTYPE: MEL 62413, not seen).

Perennial aquatic herb, monoecious or hermaphroditic. Stems 30–50 (–80) cm long, to 2 mm in diameter, sparsely branched, freely floating. Leaves alternate or whorled, dimorphic. Submerged leaves scattered or in whorls of 4–5, broadly ovate in outline, 2.0–3.0 cm long, 1.0–2.0 cm wide, spreading to recurved, with 4–10 (or more) pairs of filiform, brown-tipped, finely mucronate, 5–10 mm long segments; emergent leaves alternate, the upper ones narrowly oblanceolate to linear, 0.7–1.7 cm long, 0.5–1.5 wide, spreading or upward erect-spreading, shortly toothed above the middle or entire. The lower emergent leaves shortly pinnately divided. Bracteoles cucullate, acute, 0.7–0.8 mm long, red-hyaline. Male and bisexual flowers in irregular dichasia of 1–3 (–5), in axils of emergent leaves; female flowers borne on the submerged parts. Male flowers 4-merous, sessile; sepals 4, deltoid, ca. 0.2 mm long; petals 4, ca. 1.8 mm long, tardily caducous, red; stamens 4, anthers stiffly erect, linear-lanceolate, ca. 1.5 mm long, ca. 0.3 mm wide. Bisexual flowers similar to male flowers, ovary 4-celled, styles 4, fimbriate stigmas developing after pollen release. Female flowers 2-merous, sessile or pedicellate; sepals 2, deltoid, ca. 0.1 mm long; petals absent; ovary 2-locular; styles clavate; stigmas capitate, non-fimbriate, red. Fruit sessile, or with a short pedicel to ca. 0.2 mm long, 2-locular (in female flowers) or 4-locular (in bisexual flowers), olive-brown; mericarps cylindrical, 1.0–1.2 mm long, ca. 0.4 mm wide, truncate, smooth but minutely and sparsely tuberculate on dorsal surface, and indistinctly lengthwise lineolate on the surface, styles persistent.

Myriophyllum dicoccum is a species that has female flowers under water and emergent bisexual flowers near the water surface. The development of two types of fruits on the same plant is unique for the genus: 4-locular in bisexual flowers and 2-locular in female flowers. The bilocular submerged fruits make this species readily recognizable.

Li and Hsieh (1996) reported that *Myriophyllum dicoccum* occurs in Taiwan. We found this species also occurs in Guangdong, Guangxi, and Fujian of South China. The species was erroneously treated as *M. humile* in both *Flora of Guangzhou* (How 1956)

and *Flora Reipublicae Popularis Sinicae* (Wan 2000). We have examined the original materials (*S. H. Chun* 8341, IBSC), which were cited in the *Flora of Guangzhou*, and other specimens from China which were referred to *M. humile*, and found that the cited specimens belong without exception to *M. dicoccum*, as shown by two types of fruits on the one plant and bilocular submerged fruits characteristic of the species. Furthermore, descriptions and illustrations annotated as *M. humile* by a number of authors (*Chun* 1964; *Diao* 1990; *How* 1956; *Wan* 2000; *Wang et al.* 1983; *Yan* 1983) fit *M. dicoccum*. Thus, the species *M. dicoccum* within China has long been mistaken for *M. humile*. These two taxa are easily distinguished by their fruits. In addition, *M. dicoccum* is bound to a seasonal climate and confined to Australia, East India, North Vietnam, Northeast Java, New Guinea, and northward to South China; *M. humile* occurs mainly in New England and other northeastern parts of the United States (*Crow* 1993; *Muenschler* 1944). From the available materials, it seems that *M. humile* does not occur in China.

DISTRIBUTION. South China (Fujian, Guangdong, Guangxi, and Taiwan); also occurring in almost all parts of Australia (especially northern Australia), eastern India, North Vietnam, northeastern Java, and New Guinea.

REPRESENTATIVE SPECIMENS EXAMINED: CHINA. Fujian: Liancheng, near Dongjiang, 7 Oct 1932, *Y. Ling* 3775 (PE). Guangdong: Guangzhou, 30 Aug 1934, *Y. Li* 10013 (IBSC); Guangzhou, Honam Island, 5 Jul 1953, *S. H. Chun* 8341 (IBSC, PE); Boluo, near Luofu Mountain, 3 Oct 1978, *Guangdong Exped.*-78 6410 (IBSC); Chaoan, 17 Aug 1980, *Z. C. Zhao* 0488 (WH); Suixi, 5 Dec 2001, *D. Wang* 1402 (WH). Guangxi: Dongxing, 23–24 Aug 2001, *D. Wang & Y. M. Huang* 911, 936 (WH), 20 Nov 2001, *D. Wang* 1322 (WH). Taiwan: Taipei, Neihu, 26 Sep 1939, *G. Masamune* s.n. (TAI).

4. *Myriophyllum heterophyllum* Michx., *Fl. Bor.-Amer.* 2: 191. 1803. TYPE: NORTH AMERICA.

Perennial aquatic herb, monoecious. Stems up to 100 cm. Leaves in whorls of 4–5. Submerged leaves subverticillate or scattered, crowded, up to 5 cm long, pinnately divided, with 5–12 pairs of pinnae per leaf. Spike 3–35 cm long, with flowers borne in the axils of floral bracts. Floral bracts linear, ovate or lanceolate, margin serrate or rarely entire, much longer than the length of the flowers. Bracteoles ovate, serrate, ca. 1.2 mm long and 0.6 mm wide. Flowers hermaphroditic, or occasionally fe-

male at base of inflorescence, male above. Petals 1.5–3 mm long. Stamens 4. Fruits 1.0–1.5 mm long, slightly longer than thick, subglobose, mericarps beaked and with 2 finely tuberculate ridges on the outer face.

This naturalized species is newly recorded for China. The specimen collected from southeast China by Levire (794, PE) was erroneously referred to *Myriophyllum verticillatum*. The specimen belongs to *M. heterophyllum* due to its blade shape. *Myriophyllum heterophyllum* has floral leaves linear, ovate or lanceolate, serrate to almost entire, while *M. verticillatum* has floral leaves pectinate or pinnate. The mericarps also differ in that *M. heterophyllum* has mericarps beaked with two finely tuberculate ridges on the dorsal surface, *M. verticillatum* mericarps are dorsally smooth.

DISTRIBUTION. Native to North America, where it extends from southwestern Quebec, Ontario, and North Dakota south to Florida and New Mexico; introduced and naturalized in Europe (southeast Austria, Britain, and Ireland) and South China (Guangdong).

REPRESENTATIVE SPECIMEN EXAMINED: CHINA. Guangdong: Guangzhou, Honam Island, 3 Oct 1917, Levire 794 (PE).

5. *Myriophyllum oguraense* Miki, Bot. Mag. (Tokyo) 48: 335. 1934. TYPE: JAPAN.

Perennial submerged herb, monoecious. Stems branched mainly at the base. Leaves 4 (–5) whorled, dimorphic. Submerged leaves, ovate to suborbicular in outline, 2.4–5.7 cm long, 2.3–5.5 cm wide, pectinate with 9–13 filiform pinnae. Emergent leaves glaucous, light bluish-green, oblanceolate in outline, 4.5–6 (–9.5) mm long, 1.2–2.5 (–4) mm wide, pectinate with 7–9 (–13) linear-subulate pinnae, tips reddish brown; scale hairs present near the dorsal axils of the pinnae. Inflorescence a simple spike or sometimes with additional 2–10 lateral inflorescences; both main and lateral inflorescences 2.5–9.5 cm long, with axillary unisexual flowers subtended by two bracteoles, upper ones male, lower ones female. Bracteoles white, trifid to pectinate with 2–3 pinnae. Male flowers 4-merous, sessile; sepals 4, green, deltoid, 0.5–0.8 mm long, 0.4–0.6 mm wide; petals 4, white to pale green, 1.8–2.8 mm long, 0.8–1.2 mm wide, hooded, weakly keeled at the base, caducous at anthesis; stamens 8, filaments lengthening to 1.2–1.6

mm long at anthesis, cream; anthers linear-oblong, yellow, 1.4–2.0 mm long, 0.2–0.4 mm wide; ovary 4-locular, reduced, pale green to reddish. Female flowers 4-merous, sessile; sepals 4, 0.4–0.6 mm long, 0.3–0.5 mm wide, green, deltoid; petals 4, white, slightly hooded, 0.5–0.9 mm long, 0.2–0.4 mm wide, caducous; styles 4, short, less than 0.4 mm long; stigmas shortly fimbriate, white, pinkish after anthesis; ovary 4-locular. Fruits sessile, olive brown, shortly cylindrical; each mericarp with 2 longitudinally smooth ridges on dorsal surface and lateral longitudinal ridges at the junction with adjoining mericarps.

Myriophyllum oguraense is newly recorded in China. Its emergent leaves are glaucous, which is very rare among the native species of Chinese *Myriophyllum* and observed only in the exotic *M. aquaticum* in aquaria (see above). It is very distinct from *M. aquaticum* in floral characters and habit (for details see the key, notes under each species). In appearance *M. oguraense* is similar to *M. verticillatum* but differs in the color of the emergent leaves and the long, cylindrical turion. *Myriophyllum oguraense*, described by Miki in 1934, has been considered an endemic species to Japan since being described (Hara 1954; Iwatsuki 1992; Kadono 1994; Miki 1934, 1937; Ohwi 1953, 1975; Ohwi and Kitagawa 1992). The discovery of this species in China shows that this species is confined to East Asia with its distribution extending from China to Japan.

DISTRIBUTION. China (Anhui, Heilongjiang, Hubei, Jiangsu, Jiangxi, and Zhejiang). Found in the distributaries of the Yangtze River Basin and northeastern China; also occurs in Japan.

REPRESENTATIVE SPECIMENS EXAMINED: CHINA. Anhui: Chaocheng, 22 Sep 1951, *Statio Orientali-Sinensis* 3938 (PE); Xuancheng, 18 Nov 1959, *T. Y. Liu* 586 (WH); Dangtu, 30 Aug 1959, *T. Y. Liou* 1018 (WH). Heilongjiang: Ningan, Jingbohu Lake, 18 Jul 1990, *D. Yu* 907102 (WH). Hubei: Wuhan, Donghu Lake, 3 Oct 1993, *D. Yu* 931010, 931011 (WH); Shishou, no date, *D. Yu* s.n. (WH); Ezhou, 20 May 2001, *D. Wang* 699 (WH), 11 Nov 2001, *D. Wang* 1271 (WH). Jiangsu: Suzhou, 13 May 1933, *H. Migo* s.n. (WH); Jintan, 18 Oct 1956, *M. B. Deng* 3654 (PE). Jiangxi: Dongxiang, 30 Jul 2001, *D. Wang* 808 (WH). Zhejiang: Quzhou, 11 Oct 1998, *Y. X. Chong* 9810067, 9810068 (WH); West Lake, 15 Jun 1927, *H. H. Hu* 1518 (PE).

6. *Myriophyllum sibiricum* Kom., Repert. Spec. Nov. Regni. Veg. Beih. 13: 168. 1914. TYPE: RUSSIA, Kamchatka River Basin,

no date, *N. F. Komarov 4855* (LECTOTYPE: LE, selected by S. G. Aiken and A. Cronquist in *Taxon* 37: 958. 1988).

Myriophyllum exalbescens Fernald, *Rhodora* 21: 120. 1919. *M. spicatum* L. var. *exalbescens* (Fernald) Jeps., *Man. Fl. Pl. Calif.* 691. 1925. *M. spicatum* L. subsp. *exalbescens* (Fernald) Hultén, *Acta Univ. Lund.* 43(1): 1159. 1947. TYPE: CANADA. Québec: Gaspé Co., York River, 29 Jul 1905, *Williams, Collins & Fernald s.n.* (HOLOTYPE: GH).

Myriophyllum spicatum L. var. *muricatum* Maxim., *Bull. Acad. St.-Pét.* 19: 182. 1873. TYPE: JAPAN. Yokoska, *Savatier s.n.* (LR, "syntype, not seen"); AFGHANISTAN. *Griffith 2442* (K, "syntype, not seen"); SICILY. Palermo, *Todaro 471* (K, "syntype, not seen").

Perennial aquatic herb, monoecious. Submerged leaves in whorls of 4–5, pinnately divided, with 7–12 pairs of pinnae per leaf. Inflorescence a simple spike with flowers borne in the axils of floral bracts. Floral bracts acute, shorter than or rarely equaling fruits in length, lower bracts serrate, upper ones spatulate-ovate or oblong-cochloform; bracteoles entire, ovate, longer than broad or equal. Petals absent in the female flowers. Stamens 8; anthers 1.2–1.8 mm long. Fruits 4-sulcate, globose, 1.8–2.6 mm long, 1.8–2.6 mm wide; mericarps dorsally tuberculate or aculeate.

Myriophyllum sibiricum is a newly recorded species to China. It has long been confused with *M. spicatum*. The representative characters that separate these species are, for *M. sibiricum*: 1) submerged leaves with 7–12 pairs of pinnae per leaf; 2) mericarps dorsally tuberculate or aculeate; 3) floral bracts acute and shorter than or rarely equaling fruits in length; bracteoles ovate to longer than broad; 4) anthers 1.2–1.8 mm long; 5) stems below the inflorescence have no conspicuous change in width, straight; and 6) cylindrical turions well developed, and turion leaves dark. For *M. spicatum* the representative characters are: 1) submerged with 14–24 pairs of pinnae per leaf; 2) mericarps mostly smooth or finely tuberculate on dorsal surface; 3) floral bracts rounded and equal to or longer than fruits; bracteoles reniform to suborbicular, broader than long; 4) anthers 1.8–2.2 mm long; 5) stems below inflorescence almost double the lower parts in width, very rigid, characteristically curved; and 6) turions not developed.

Myriophyllum sibiricum and *M. spicatum* have been distinguished as two distinct species by many authors (Aiken 1979; Aiken and Cronquist 1988; Aiken and McNeill 1980; Aiken and Walz 1979; Aiken et al. 1979; Ceska and Ceska 1986; Correll

and Correll 1975; Löve 1961; Mathewes 1978). The taxa in North America are not readily separated on pollen morphology (Aiken 1978; Mathewes 1978). However, differences in pollen morphology were described by Faegri (1982). Also, flavonoid patterns in these two taxa are different (Ceska 1977). Both species have chromosome numbers $2n = 42$ throughout their North American range (Löve 1961).

Myriophyllum sibiricum is confined to cold temperate regions (Aiken and McNeill 1980; Ceska and Ceska 1986; Faegri 1982; Patten 1954) while *M. spicatum* is ubiquitous in boreal and temperate regions of the Northern Hemisphere, and ranges from Europe to Asia and from sub-arctic to equatorial latitudes. In their overlapping areas of distribution the species should be studied further.

DISTRIBUTION. China [Heilongjiang, Inner Mongolia, Jiangsu, Jilin, Qinghai, Sichuan, Xizang (Tibet), Xinjiang, and Yunnan]; also occurs in cold-temperate zone of northern Eurasia from Scandinavia to Kamchatka and North America.

REPRESENTATIVE SPECIMENS EXAMINED: CHINA. Heilongjiang: Heihe, 16 Aug 1988, *D. Yu* 80071 (NEFI); Xinghua, 20 Aug 1988, *D. Yu* 80089 (NEFI). Inner Mongolia: Kuduer, 17 Jul 1990, *D. Yu* 907063 (NEFI), 29 Jun 1991, *D. Yu* 916011 (NEFI), 21 Jul 1991, *D. Yu* 917119 (NEFI); Arongqi, no date, *D. Yu* 85030, 86153 (NEFI). Jiangsu: Jingtian, 18 Oct 1956, *M. B. Deng* 3657 (PE). Jilin: near Chingpohu, 13 Aug 1931, *H. W. Kung* 2063 (PE). Qinghai: Gonghe, no date, *The Geog. Pl. Exped.* 487 (PE); Ulan, 9–10 Aug 1982, *Y. D. Chen & R. S. Ni* 313, 322, 327, 329 (PE). Sichuan: Xikang, Yanduo, 19 Sep 1951, *Y. W. Cui* 5749 (PE); Songpan, 19 Jul 2000, *D. Yu* 00075051 (WH); Tangke, 21 Jul 2000, *D. Yu* 00075178 (WH); Litang, 29 Jun 1992, *Z. C. Zhao* 0417 (CDBI); Luhuo, 5 Jul 1992, *Z. C. Zhao* 0480 (CDBI); Hongyuan, 22 Sep 2000, *D. Yu* 00075210 (WH); 23 Jul 1991, *Z. C. Zhao* 910147 (CDBI). Xizang (Tibet): Bangong Lake, *Y. X. Qu* 62576 (NAS). Xinjiang: Chahannuoer Lake, 12 Aug 1965, *T. Y. Cheo* 651386 (PE, NAS).

7. *Myriophyllum spicatum* L., Sp. Pl. 992. 1753. TYPE: EUROPE. Herb. Burser VII (1) 79. (LECTOTYPE: UPS, selected by S. G. Aiken and J. McNeill in *J. Linn. Soc., Bot.* 80: 216. 1980).

Perennial aquatic herb, monoecious. Submerged leaves in whorls of 4–5, pinnately divided, with 14–24 pairs of pinnae per leaf. Inflorescence a simple spike with flowers borne in the axils of floral bracts, the upper flowers male, the lower flowers female, with bisexual flowers between them. Floral bracts rounded, equal to or longer than fruits; the lower bracts lanceolate, pectinate; the

upper bracts rhombic to elongate, entire. Bracteoles entire, reniform or suborbicular, broader than long, 0.5–0.8 mm long. Petals absent in the female flowers. Stamens 8; anthers 1.8–2.2 mm long. Fruits 4-sulcate, globose, 1.8–2.6 mm long, 1.8–2.6 mm wide; mericarps mostly smooth or finely tuberculate on dorsal surface.

Myriophyllum spicatum is found throughout China, except the northern regions of the Chang Tang Plateau (Tibet), making it the most widespread species of *Myriophyllum* in China. Described from Europe, *M. spicatum* has often been confused with *M. sibiricum*. The confused identifications especially exist in the collections from northeast and southwest China. The same result was found in studies on *M. spicatum* in North America and North Eurasia (Aiken et al. 1979; Faegri 1982). However, they are distinct taxa (for differences see the notes under *M. sibiricum*).

DISTRIBUTION. Widely distributed in Eurasia, naturalized in North America, rare in Africa and the Tropics.

REPRESENTATIVE SPECIMENS EXAMINED: CHINA. Anhui: Jingxian, no date, *D. Han* 838 (NAS); Bohu Lake, 16 Sep 1993, *D. Yu* 930914 (WH); Wuchanghu Lake, 20 Oct 2001, *Z. Q. Li et al.* 2001100069 (WH); Huangda Lake, 14 Sep 1993, *D. Yu* 930930, 930936 (WH); Quanjiao, 14 Sep 1951, *Statio Orientali-Sinensis* 3705 (PE); Congyang, 23 Oct 2001, *Z. Q. Li et al.* 2001100096 (WH); Chaohu Lake, 25 Oct 2001, *Z. Q. Li et al.* 2001100107 (WH). Gansu: Wudu, 21 Jul 2000, *D. Wang & Z. Q. Li* 00070006a (WH). Fujian: Xiamen, 20 Nov 1978, *G. L. Cai* 00665 (PE). Guangdong: Yingde, Wentongshan, 19 Oct 1931, *H. Y. Liang* 61408 (PE); Yingde, Hengshitang, 19 Aug 2001, *D. Wang & Y. M. Huang* 909 (WH); Shantou, no date, *Y. D. Chen & R. S. Ni* 309 (PE). Guangxi: Yanshan, 15–17 Nov 2001, *D. Wang et al.* 1275, 1295 (WH); Guiping, 28 Nov 2001, *Z. Q. Li et al.* 20011100114 (WH); Luocheng, 2 Dec 2001, *Z. Q. Li et al.* 20011100191 (WH). Guizhou: Danzhai, 13 Aug 2001, *Z. Q. Li & Y. Q. Yang* 20010126 (WH); Duyun, 14 Aug 2001, *Z. Q. Li & Y. Q. Yang* 20010147 (WH); Longli, 17 Aug 2001, *Z. Q. Li & Y. Q. Yang* 20010169 (WH); Qingzhen, 19 Aug 2001, *Z. Q. Li & Y. Q. Yang* 20010188 (WH); Caohai Lake, 24 Aug 2001, *Z. Q. Li & Y. Q. Yang* 20010202 (WH). Hebei: Beijing, Western Hills, 20 Apr 1930, *T. N. Liou* 6924 (PE); Beidaihe, 20 Aug 1951, *F. T. Wang* 0116 (PE); Hsiaowutaishan (Xiaowutaishan), 17 Jun 1930, *H. W. Kung* 393 (PE), 28 Jun 1931, *T. P. Wang* 423 (PE); Anxin, Baiyangdian Lake, 26 Jul 1979, *Y. D. Chen & R. S. Ni* 66 (WH, PE); Anxin, Beihezhuang, 18–19 May 1961, *Y. Z. Chao* 48, 63 (PE); Chengde, 16 Sep 1962, *W. Wang* 3011 (IFP); Miyun, *Y. D. Chen* 516 (PE); Rehe, 13–17 Sep 1952, *T. N. Liou* 5041, 5368 (PE, IFP); Fanshan, 28 May 1971, *Beijing Med. Exped. Fangshan-group* 174 (PE); Baoding, 6 Jul 1989, *Botany teaching and research sect., Hebei Agric. Univ.* 4146 (PE); Changping, 9–10 Jun 1952, *N. Y. Liu & Z. S. Zhang* 5, 12,

17 (PE). Heilongjiang: Wudaliangchi Lake, 10–15 Sep 1990, *D. Yu 908043* (NEFI); Kengka (Xingkai) Lake, 9 Aug 1987, *D. Yu 00103* (NEFI); Anda, 8 Jul 1991, *D. Yu 917066* (NEFI); Fulaerji, no date, *Jernakov 1784, 2532* (HNR); Haerbin, 28 Aug 1951, *Skvortzov & G. Z. Wang 1237* (PE); Mishan, 23 Sep 1952, *G. Z. Wang 736* (PE). Henan: Xuchang, 27–28 May 1932, *K. S. Hao 3272, 3317* (PE); Huaiyang, 24 Apr 1935, *T. S. Hwa 24* (PE); Huangchuang, 31 Jun 1959, *Henan Institute, Acad. Sin. 29183* (PE). Hubei: Donghu Lake, 29 Aug 1956, *Z. H. Qian 1640* (WH), 23 Oct 1957, *Z. H. Qian 2686* (WH), 19 Aug 1993, *D. Yu 938094* (WH); Liangzi Lake, 16 Jun 1993, *D. Yu 936101* (WH); Yunihu Lake, 21 Oct 1993, *D. Yu 931067* (WH); Honghu Lake, 30–31 Aug 1993, *D. Yu 938128, 938145* (WH); Changhu Lake, 14 Aug 1993, *D. Yu 938074, 938075* (WH); Futouhu Lake, 16 Jul 1993, *D. Yu 937168* (WH); Baoan Lake, 3 Aug 1993, *D. Yu 938014, 938036* (WH); Huangjia Lake, 28 Jul 1993, *D. Yu 937191* (WH); Qingling Lake, 30 Jul 1993, *D. Yu 937210, 937221* (WH). Hunan: Baojing, 28 Sep 1958, *L. H. Liu 09982* (PE); Dongting Lake, 23 Jun 1993, *D. Yu 936123* (WH); Lianyuan, 2 Aug 2001, *Z. Q. Li & Y. Q. Yang 20010047* (WH); Huaihua, 4 Aug 2001, *Z. Q. Li & Y. Q. Yang 20010051* (WH); Loudi, 1 Aug 2001, *Z. Q. Li & Y. Q. Yang 20010035* (WH); Liling, 16 Nov 2001, *Z. Q. Li et al. 2001110003* (WH); Youxian, 17 Nov 2001, *Z. Q. Li et al. 2001110018* (WH); Chaling, 20 Nov 2001, *Z. Q. Li et al. 2001110062* (WH); Daoxian, 24 Nov 2001, *Z. Q. Li et al. 2001110077* (WH). Inner Mongolia: Wulan, 24 Aug 1956, *X. Z. Lang 75* (PE); Xixinbaqi, 29 Jun 1951, *Z. Wang 1007* (PE). Jiangsu: Nanjing, Qixia Mt., 27 Apr 1929, *Y. L. Keng 2147* (PE); Yuntai Mt., 3 Sep 1958, *F. Y. Liu 10968* (PE); Changsu, 20 Aug 1958, *W. X. Wu 0738* (PE); Xuanwuhu Lake, no date, *S. L. Chen 26* (NAS); Hongzehu Lake, 5 Sep 1993, *D. Yu 939001* (WH); Taihu Lake, 28 Oct 2001, *Z. Q. Li et al. 2001100136* (WH); Yixing, 28 Oct 2001, *Z. Q. Li et al. 2001100146* (WH); Wuxian, 28 Oct 2001, *Z. Q. Li et al. 2001100156* (WH); Liyang, 27 Oct 2001, *Z. Q. Li et al. 2001100121* (WH). Jiangxi: Dongxiang, 31 Jul 2001, *D. Wang & Y. M. Huang 817* (WH), Pingxiang, 9 Nov 1954, *Jiangxi Exped. 2938, 2939* (PE, NAS); Poyanghu Lake, 16 Oct 2001, *Z. Q. Li et al. 2001100006* (WH); Shahu Lake, 17 Oct 2001, *Z. Q. Li et al. 2001100023* (WH); Banghu Lake, 18 Oct 2001, *Z. Q. Li et al. 2001100053* (WH). Jilin: Linjiang, no date, *Noda 824* (IFP). Liaoning: Xinmin, no date, *Y. C. Zhu 1159* (IFP); Zangwu, no date, *Z. Wang 2566* (IFP); Beizhen, no date, *Y. L. Zhang 2786* (IFP); Faku, no date, *Y. C. Zhu 581* (IFP); Panshan, no date, *C. F. Fang 128* (IFP); 26–28 Jul 1981, *Q. Y. Li & M. Q. Pan 221, 227* (WH); Benxi, no date, *Q. L. Wang 404* (IFP). Qinghai: Ulan, 11 Aug 1982, *Y. D. Chen & R. S. Ni 347* (PE); Kelukehu Lake, 7 Aug 2000, *D. Wang and Z. Q. Li 00080071* (WH). Shaanxi: Wugong, 30 Apr 1938, *S. T. Wang 405* (PE); Hsin-an, 27 Jul 1933, *C. W. Wang 61145* (PE); Yulin, Qixing River, 8 Aug 1953, *Y. W. Tsui 10420* (PE); Zhouzhi, 2 Aug 1998, *D. Wang 980802* (WH); Taibaichi, no date, *T. N. Liou & P. C. Tsoong 2408* (PE); Yulin, 19 Jul 1953, 17 Jul 1938, *K. J. Fu 6962* (PE); Hanzhong, 12–25 Aug 1998, *D. Wang 980812, 980825* (WH); Chenggu, 4 Jun 1999, *D. Wang 990604* (WH); Nanzheng, 25 Aug 1998, *D. Wang 980825* (WH). Shandong: Weishan, 9 Aug 1959, *T. Y. Cheo 6911* (PE), 19 Jul 1980, *Y. D. Chen & R. S. Ni 119* (PE), 30 Jun 1983, *G. S. Jiu 02* (PE). Shanghai: Pudong, no date, *J. X. Tan 341* (NAS); Caohe, no date, *Y. W. Law 1638* (NAS). Sichuan: Guanghan, Lianshan, 1 Sep 1939, *T. N. Liou & C. Wang 555* (PE);

Shunching, 10 May 1930, *K. S. Hao 153* (PE); Rongxian, 28 Aug 2001, *Z. Q. Li & Y. Q. Yang 20010247* (WH); Muchuan, 31 Aug 2001, *Z. Q. Li & Y. Q. Yang 20010253* (WH); Litang, 29 Jun 1992, *Z. C. Zhao 0420* (CDBI); Kangding, 24 Jun 1992, *Z. C. Zhao 0370* (CDBI); Daofu, 13 Aug 2000, *S. L. Xia & Z. H. Wu 00086031* (WH); Daochen, 28 May 1973, *Sichuan Vegetation-Exped., Daochen-group 1712* (PE); Le-po-Hsian, 28 Jul 1934, *T. T. Yu 3290* (PE); Xichang, Qionghai, 29 May 1964, *L. N. Zhao 2196* (PE). Taiwan: Taipei, NTU Campus, 2 Oct 1974, *C. M. Kuo 5897* (TAI); Taipei, Shenkeng, 12 May 1907, *T. Kawakami 5742* (HAST); Yingko, 9 Sep 1908, *S. Sasaki s.n.* (TAI); Taoyuan, Tachi, 2 Aug 1960, *L. S. Liao s.n.* (TAI); Taoyuan, 23 Oct 1990, *C. I. Peng 13,526* (HAST); Hsinchu, Hsinfeng, 6 Feb 1984, *C. I. Peng 6391* (HAST); Chiayi, 10 Feb 1969, *C. E. Devol 9014, 9016* (TAI); Chiayi, Potzu, 24 Jul 1913, *M. Kitashima s.n.* (TAI); Taitung, 8 Aug 1913, *Y. Yamamoto s.n.* (TAI). Xinjiang: Bositenghu Lake, 1 Oct 1980, *F. K. Yi 378* (PE), 11 Sep 1998, *D. Yu & S. L. Xia 9809636* (WH), no date, *Y. H. Guo X027* (WH); Buerjing, Ganasiyu Lake, 14 Aug 1998, *D. Yu & S. L. Xia 9808134* (WH); Fuhai, 15 Aug 1998, *D. Yu & S. L. Xia 9808163* (WH); Akesu, 30 Aug 1998, *D. Yu & S. L. Xia 9808450* (WH). Xizang (Tibet): Lasha, 27 Aug 1965, *Y. T. Zhang & K. Y. Lang 2163* (PE); Yigong, 19 Jul 1965, *J. S. Ying & D. Y. Hong 0652* (PE); Cuomei, Zheguhu Lake, 29 Sep 2001, *D. Wang et al. 1046* (WH); Payang, 10 Sep 2000, *D. Wang & Z. Q. Li 90267* (WH); Dangxiong, 24 Aug 2000, *D. Wang & Z. Q. Li 80112* (WH); Linzhou, 18 Sep 2000, *D. Wang & Z. Q. Li 90295* (WH); Linzhi, 20 Sep 2000, *D. Wang & Z. Q. Li 90306* (WH); Dazi, 22 Sep 2001, *D. Wang 982* (WH). Yunnan: Kunming, no date, *B. Y. Qiu 70088* (HIB), 29 Jul 1982, *Q. Xia & Y. L. Ma 00003* (PE); Dianchi, 27 May 1957, *B. Y. Qiu 54048* (PE); Dali, May 1935, *C. W. Wang 63491* (PE); Jianhu Lake, 2 Nov 2000, *D. Wang 00010427* (WH); Lijiang, Jun 1935, *C. W. Wang 70588* (PE); Lashihai Lake, 3 Nov 2001, *D. Wang 00011442* (WH); Zhongdian, 31 Jul 1937, *T. T. Yu 12517* (PE); Deqin, 30 Aug 1999, *D. Wang & Z. Q. Li 990103a* (WH); Yongning, Lugu Lake, 4 May 1937, *T. T. Yu 5263* (PE); Dongchuan, 2 Sep 1932, *H. T. Tsai 51967* (PE); Zhaotong, 26 Aug 2001, *Z. Q. Li & Y. Q. Yang 20010226* (WH). Zhejiang: Ling-an, Hualong, 18 Aug 1929, *K. K. Tsoong 721* (PE); West Lake, 18 Sep 1927, *K. K. Tsoong 1505* (PE); Wuxing, no date, *F. X. Liu 1685* (NAS); Huzhou, 10 Sep 1959, *Zhejiang Exped. 29756* (PE); Yongkang, 9 Nov 1993, *Q. F. Wang 109* (WH).

8. *Myriophyllum tetrandrum* Roxb., *Fl. Ind.* 1: 470. 1820. TYPE: EAST INDIA. W. Roxburgh, *Icones Roxburghianae*, pl. 551 (HOLOTYPE: plate 551 at K, not seen).

Perennial aquatic herb, monoecious. Stems few branched. Submerged leaves in whorls of (4–) 5(–6), 3.0–4.0 cm long, 10–11 mm wide, pinnately divided, with 10–16 pairs of pinnae per leaf. Lowermost emergent leaves pinnate with 9–13 pairs of short lobes, rather stiffly spreading, lobes 0.4–0.6 mm long; middle and upper emergent leaves in whorls of 5, lanceolate to linear-lanceolate in outline, 4.0–5.0 mm long, 1.0–1.5 mm wide, with 6–12 pairs of erect-spreading, subulate, brown-tipped, very acute

lobes. Inflorescence a simple spike with axillary, unisexual flowers, upper ones male, lower ones female. Bracteoles digitately lobed, 0.6–1.0 mm long. Sepals triangular, 0.15–0.2 mm long, 0.1–0.15 mm wide, entire or finely serrate, acute. Petals spatulate, 1.0–1.5 mm long, ca. 0.4 mm wide, entire, caducous after anthesis. Stamens 4, anthers oblong, 0.6–0.8 mm long. Fruits cruciform, ca. 2.0 mm long, ca. 2.0 mm wide, mericarps ovate, with convex back and flattened sides, irregularly and finely tuberculate to smooth.

The Chinese *Myriophyllum tetrandrum* was first reported by Chun (1964); no fruit description was given. Based on the specimens collected by S. K. Lau (5743, IBSC), the fruit is cruciform, mericarps ovate and smooth, with convex back and flattened sides.

Myriophyllum tetrandrum and *M. indicum* Willd. are closely allied but distinct species. Their similarities are: monoecy, pinnately or digitately dissected bracteoles, fruits ca. 2 mm long, ovate mericarps, finely tuberculate to smooth. They differ in that *M. tetrandrum* has 4 stamens, oblong anthers 0.6–0.8 mm long, petals 1.0–1.5 mm long, and is confined to Northeast India and Indo-China; *M. indicum* has 8 stamens, linear anthers 1.5–1.8 mm long, petals 1.5–2 mm long, and is found in Ceylon and South Deccan (Cook 1996; Meijden and Caspers 1971). Differences in pollen grains also exist (Praglowksi 1970).

DISTRIBUTION. Hainan Island; also occurs in the eastern and northern parts of India, South Thailand, North Vietnam, and Malay Peninsula.

REPRESENTATIVE SPECIMEN EXAMINED: CHINA. Hainan: Yai-hsien District (Yaxian), 19–29 Mar 1935, S. K. Lau 5743 (IBSC).

9. *Myriophyllum tuberculatum* Roxb., Fl. Ind. 1: 471. 1820. TYPE: EAST INDIA.

Perennial aquatic herb, monoecious. Stems much branched. Leaves usually heterophyllous; submerged leaves in whorls of 4–5, 2.5–4.0 cm long, 1.0–1.5 cm wide, pinnately divided, with 8–25 pairs of filiform lobes, the lobes 1–2 cm long; emergent leaves in lower part like the submerged ones but smaller, the upper ones ultimately alternate, with less and shorter lobes, the uppermost ones entire, spatulate to linear, 5–20 mm long. Floral

bracts leaf-like; bracteoles rhomboid, serrate, 1.2 mm long, 0.8 mm wide, acute. Flowers borne in axils of emergent leaves, the lowest sometimes female, followed by bisexual ones, with male ones above. Sepals orbicular, 0.1–0.25 mm long and wide, finely serrate or entire. Petals 4, 0.5–1.5 mm long, white. Stamens 4; anthers elliptical to oblong, 0.5–1.0 mm long. Fruits quadrangular, 2.5–3.5 mm long and wide, with sharp longitudinal ribs, both ribs and furrows with pointed tubercles.

Myriophyllum tuberculatum is a newly recorded species to China. *Myriophyllum tuberculatum* may be confused with *M. indicum*. They differ in that *M. tuberculatum* has: 1) stamens 4; 2) anthers elliptical-oblong, 0.5–1 mm long; 3) the upper floral leaves alternate; 4) bracteoles rhomboid, serrate, acute; and 5) fruit quadrangular in transverse section, with sharp longitudinal ribs, both ribs and furrows with pointed tubercles, mericarps dorsally acute. *M. indicum* has: 1) stamens 8; 2) anthers linear, 1.5–1.8 mm long; 3) upper floral leaves whorled; 4) bracteoles pinnate or digitate; and 5) fruit cruciform in section, mericarps ovate, finely tubercled or smooth. *Myriophyllum tuberculatum*, in addition, is confined to South and Southeast Asia. Records of *M. tuberculatum* from Australia (Aston 1977; Cook 1996; Meijden 1969; Meijden and Caspers 1971) have proven to be erroneous (Orchard 1990).

DISTRIBUTION. South China (Guangdong); also occurs in India, Bangladesh, Myanmar, the northern Malay Peninsula, southeast Borneo, and Sunda Islands.

REPRESENTATIVE SPECIMENS EXAMINED: CHINA. Guangdong: Ying-Tak (Yingde), Wentongshan, 19 Oct 1931, *H. Y. Liang* 61409 (PE); Yingde, Hengshintang, 18 Aug 2001, *D. Wang & Y. M. Huang* 883 (WH).

10. *Myriophyllum ussuriense* (Regel) Maxim., *Mélanges Biol. Bull. Phys.-Math. Acad. Imp. Sci. Saint-Pétersbourg* 19: 182. 1873.

Myriophyllum verticillatum L. var. *ussuriense* Regel, *Fl. Ussur.* 60. 1861, tab. 4, fig. 2–5. TYPE: RUSSIA, between Songacha River and Kengka (Xingkai) Lake, Aug 1859, *R. Maack* s.n. (HOLOTYPE: LE, not seen).

Perennial aquatic or marsh herb, dioecious (very rarely monoecious). Stems weak, 5–20 cm high, emergent parts with crisped hairs. Leaves in whorls of (2–) 3 (–4). Emergent leaves entire or

serrate with 1–2 pairs of lobes, linear or lanceolate, the lower ones pinnately parted with 3–13 pairs of laciniae. Flowers sessile, borne in axils of emergent leaves; bracteoles 2, elliptic, 0.4 mm long, 0.15 mm wide, entire or serrate; sepals tubular with 4 lobes; petals 4, obovate, concaved, pale reddish; stamens 8, filaments 0.4 mm long, anthers 1.3 mm long, 0.3 mm wide; styles 4, stigmas white, long-fimbriate. Fruits subglobose, 4-sulcate, olive-brown, ca. 0.75 mm long, 0.6 mm wide; mericarps rounded on the back, finely tuberculate or rugulate.

Regel (1861) published the variety *Myriophyllum verticillatum* var. *ussuriense*, based on specimens from Kengka (Xingkai) Lake; the taxon was raised to specific level by Maximowicz (1873). This species occurs from the cold temperate areas of northeastern China south to subtropical areas of eastern and southeastern China. Collections from northeastern China are typical. They differ from those of southeastern China in being smaller in almost all of their parts. The species is variable throughout its range and in China is probably a complex. Further detailed studies are needed to understand fully the variations both within and between populations of this species. Meijden (1969) and Meijden and Caspers (1971) stated that *M. ussuriense* differs from *M. propinquum* only in minor vegetative characters and treated the taxon as a synonym of *M. propinquum*. Aston (1977) and Wan (2000) followed the same treatment. However, Orchard (1979) found these taxa to be separate species. *Myriophyllum propinquum* is typified by a New Zealand collection and occurs in Australia and New Zealand while *M. ussuriense* is found in China, Russia, Korea, and Japan. *Myriophyllum ussuriense* differs from *M. propinquum* in the shape and size of its bracteoles and smaller flowers, which are often hermaphroditic. In recognizing two distinct taxa we are following Huang (1977), Li and Hsieh (1996), Maximowicz (1873), Orchard (1979, 1990), and Yu (1992).

DISTRIBUTION. China (Anhui, Guangdong, Heilongjiang, Hubei, Jiangsu, Jiangxi, North Taiwan, and Zhejiang); also occurs in the Far East of Russia, Korea, and Japan.

REPRESENTATIVE SPECIMENS EXAMINED: CHINA. Anhui: Anking, 22 Jun 1941, Migo s.n. (NAS). Guangdong: Dinghu Mountain, 12 Apr 1966, G. L. Shi & K. M. Zhang 2711 (PE); Guangzhou, 22 Jun 1953, S. H. Chun 8335 (IBSC).

Heilongjiang: Hebei, 5 Nov 1990, *D. Yu* 901364 (NEFI); Luobei, near Fengxiang, Aug–Sep 1955, *C. S. Wang* 286 (IFP); Huma, 15 Jul 1950 *Y. C. Zhu* 137, 138 (WH, PE); Hongxing, no date, *T. Y. Ding* 56 (IFP). Hubei: Liangzi Lake, 25 Aug 1993, *D. Yu* 938101, 938102 (WH); Baoan Lake, 6 Jul 1994, *D. Yu* 947004 (WH). Jiangsu: no date, Suzhou, *Migo* s.n. (NAS). Jiangxi: Feng Dezheng, 25 Jun 1963, *M. X. Nie* 07497 (stamens 6, 2 reduced; PE); Tsoongjen, 10 Jul 1932, *Y. Tsiang* 10246 (NAS). Taiwan: Taipei, 19 Jun 1996, *Z. Y. Li* 11006 (male; PE); Taoyuan, 21 Apr 1929, *S. Sasaki* s.n. (male and female; TAI); Taoyuan, Nankan, 5 May 1929, *Y. Kudo* 578 (male; TAI), 5 May 1929, *Y. Yamamoto* s.n. (male; TAI); Hsinchu Co., Hukou, no date, *H. Simada* 4343B (female; TAI). Zhejiang: Jiangshan, Jianglang, 8 Nov 1929, *Y. Tsiang* 3133 (IBSC); Quzhou, 10 Oct 1998, *Y. X. Chong* 9810053 (WH).

11. *Myriophyllum verticillatum* L., Sp. Pl. 2: 992. 1875. TYPE: EUROPE. (LECTOTYPE: the left-hand specimen on Linn. 1123. 3, designated by S. G. Aiken and J. McNeill in J. Linn. Soc., Bot. 80: 219. 1980).

Perennial aquatic or marsh herb, monoecious. Stems robust, branched or unbranched. Leaves in whorls of 4–6. Submerged leaves pectinate with 8–16 pairs of filiform pinnae. Inflorescence a simple spike 7–25 cm long, erect, with flowers borne in the axils of floral bracts, with males in the upper, females in the lower, and a few hermaphrodite flowers between them. Floral bracts pinnate or pectinate, never entire, 1–5 times as long as the flowers, the lower as the submerged leaves, the upper lanceolate to linear-lanceolate with 8–10 pairs of rather stiff lobes; bracteoles pectinate or absent. Petals ca. 2.5 mm in male flowers, strongly reduced in female flowers. Stamens 8. Fruits ovoid or subglobose, ca. 3 mm long, smooth.

Myriophyllum verticillatum is widespread in the temperate regions of the northern hemisphere. Variability exists, especially in plants from south, north, and west China. Plants can persist as a terrestrial form for brief periods, and in this state the plants may be as small as 3 cm in length, leaves ca. 1 cm long with as few as 4 leaf-segments. Such terrestrial specimens from China can be mistaken for *M. ussuriense*. Diao (1990) discovered two variations in this species from Lijiang county, Yunnan Province in China; one with petals elongate, tardily caducous, stigmas coarsely papillose; the other, with petals not elongate, soon caducous, stigmas feathery. These variations require reinvestigation and should be treated with caution, as this species is phenotypically plastic. In North America, some varieties that had long been ap-

plied to this species are no longer recognized (Aiken 1979, 1981). Some authors state that the best field characters for identifying this species are floral bracts that are always divided, and the clavate winter turions that are formed along the stem during the late summer (Crow and Hellquist 1983; Weber and Nooden 1974). In Asia, *M. verticillatum* is easily distinguished in that all floral bracts well surpass the flowers and are laciniate-pinnatifid to the top of the spike.

DISTRIBUTION. Found in central, north, and southwest China. In Asia: east to Kamchatka and Japan, south to Afghanistan and Kashmir; North America: Canada, from British Columbia to Newfoundland, south to Maryland and California; Europe: north to Lapland, not in Iceland and Greenland; found in mediterranean Africa, as well.

REPRESENTATIVE SPECIMENS EXAMINED: CHINA. Hebei: Beidaihe, 20 Jun 1930, *W. Y. Hsia 1914* (PE); Fanshan, 18 Aug 1971, *Beijing Med. Exped. Fanshan-Group 657* (PE); Beijing, Summer Palace, 3 Jul 1953, *F. Zhao 0355* (PE); Beijing, 6 Sep 1935, *S. T. Wang 264* (PE), 18 Aug 1953, *F. Zhao 0433* (PE), 8 Oct 1951, *S. Y. Li & L. W. Xu 0145* (PE); Pinggu, 13 May 1972, *Beijing Med. Exped. 119* (terrestrial form; PE); Beijing, Prince Park, 17 Jun 1930, *T. N. Liou 6925* (PE), 8 Jun 1931, *T. P. Wang 210* (PE), 4 Oct 1930, *T. N. Liou 6927* (PE); Baiyangdian Lake, 27 Jul 1979 *Y. D. Chen & R. S. Ni 68* (PE, WH), 14 Jul 1959, *Botany teaching and research sect., Hebei Agricult. Univ. 4221* (PE). Heilongjiang: Jiayin, 13 Aug 1988, *D. Yu 80054* (NEFI); Maershan, no date, *D. Yu 85023* (NEFI); Dailing, 24 Jul 1988, *D. Yu 80016* (NEFI); Huma, 20 Aug 1988, *D. Yu 80240* (NEFI); Meixi, 10 Aug 1988, *D. Yu 80042* (NEFI); Ning-an, Jingbo Lake, 10 Sep 1981, *G. S. Zhou & Y. D. Chen 513* (PE), 15 Jul 1990, *D. Yu 907063* (NEFI); Dongjingcheng, 16–19 Jul 1990, *D. Yu 907075, 907112* (NEFI); Daqing, 8 Jul 1991, *D. Yu 917064* (NEFI); Qiqihaer, no date, *Z. S. Qin 104* (IFP); Mishan, no date, *G. Z. Wang 736* (IFP); Acheng, 10 Aug 1951, *Skvortzov & G. Z. Wang 1082* (PE). Inner Mongolia: Arongqi, no date, *D. Yu 85006, 85058* (NEFI); Erkenaqi, 24 Aug 1951, *Z. Wang 2061* (PE, IFP); Yimengzhashakeqi, Daerhute, 9 Jul 1956, *Huanghe Exped. 7295* (PE); Kuduer, 4–21 Jul 1991, *D. Yu 917055, 917105* (NEFI); Zalan-tun, no date, *Z. S. Qin 86* (IFP), no date, *Skvortzov 3485* (IFP); Wushentai, 5 Jul 1963, *Geog. Dept. of Peking University IM-164* (PE). Jiangsu: Nanjing, no date, *F. X. Liu 210* (NAS). Jilin: Huichun, no date, *C. S. Wang 2391* (IFP); Helong, 8–11 Sep 1959, *Yianbian-Group II 664, 769* (terrestrial form; PE); Antu, 27 Aug 1959, *Yianbian-Group II 393* (IFP). Liaoning: Faku, no date, *Y. C. Zhu 579* (IFP); Xinmin, no date, *Y. C. Zhu 1165* (IFP); Zhengjiatun, 6 Jun 1950, *Noda 113* (terrestrial form; PE, IFP). Shaanxi: Yulin, 26 Aug 1957, *T. P. Wang 18246* (HIB); Shanxi: Yongji, 25 Apr 1964, *C. G. Li 130* (PE). Sichuan: Ganzi, 8 Jul 1992, *Z. C. Zhao 0494* (CDBI); Hongyuan, 22 Jul 2000, *D. Yu 00075319* (WH); Ruergai, 20 Jul 2000, *D. Yu 00075102* (WH); Ruergai,

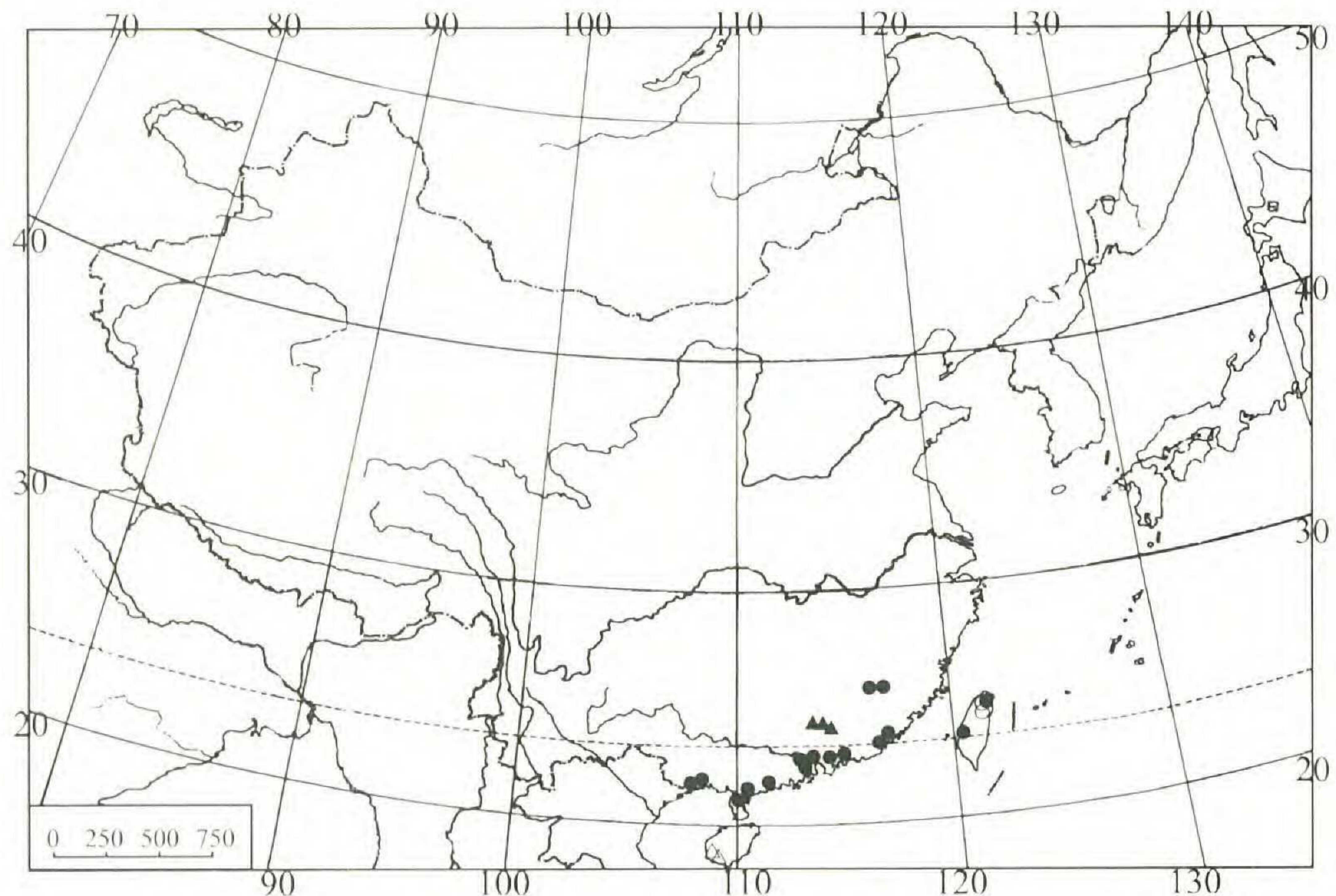


Figure 1. Distribution of Old World Tropical *Myriophyllum* in China. *M. dicoccum* (●), *M. aquaticum*, naturalized (○), *M. tuberculatum* (▲), and *M. tetrandrum* (△).

23 Oct 2001, *D. Wang & Y. K. Li* 1152 (WH); Waqie, 22 Jul 2000, *D. Yu* 00075228 (WH). Xinjiang: Cahannuoer Lake, 13 Aug 1965, *T. Y. Cheo* 651412 (NAS); Tacheng, 16 Aug 1998, *D. Yu & S. L. Xia* 9808221 (WH); Habahe, 10–11 Aug 1998, *D. Yu & S. L. Xia* 9808032, 9808038, 9808058 (WH); Fuhai, 15 Aug 1998, *D. Yu & S. L. Xia* 9808164 (WH); Zhaosu, 26 Aug 1998, *D. Yu & S. L. Xia* 9808377 (WH); Kuche, 28 Aug 1998, *D. Yu & S. L. Xia*, 9808414 (WH). Xizang (Tibet): Ritu, 15 Aug 1976, *Qinghai-Xizang Exped.* 9071, 9079 (PE); Ali, 6 Sep 2000, *D. Wang & Z. Q. Li* 00090239 (WH). Yunnan: Lijiang, Jul 1935, *C. W. Wang* 71181 (PE), 1 Sep 1999, *D. Wang & Z. Q. Li* 990128 (WH), 4 Sep 2001, *D. Wang* 946 (with flowers and fruits; WH); Heqing, Caohai Lake, 14 Nov 2000, *D. Wang* 114796 (WH); Kunming, Apr 1935, *C. W. Wang* 62948 (PE). Zhejiang: Ningbo, 22 Jun 1934, *P. J. Tsoong* 309 (PE); Hangzhou, 15 Jun 1927, *H. H. Hu* 1518 (PE).

DISTRIBUTION PATTERNS

Following Takhtajan's (1978) regionalization of the world flora, and referring to Good's (1974) scheme, the species distribution patterns of Chinese *Myriophyllum* (excluding the naturalized species *M. aquaticum* and *M. heterophyllum*) can be generalized as: 1) Old World Tropics (Figure 1), *M. dicoccum*, *M. tetrandrum*, and *M. tuberculatum*; 2) Old World Temperate (Figure 2), *M. ussuriense*; 3) North Temperate (Figures 2 and 3), *M. alterniflo-*

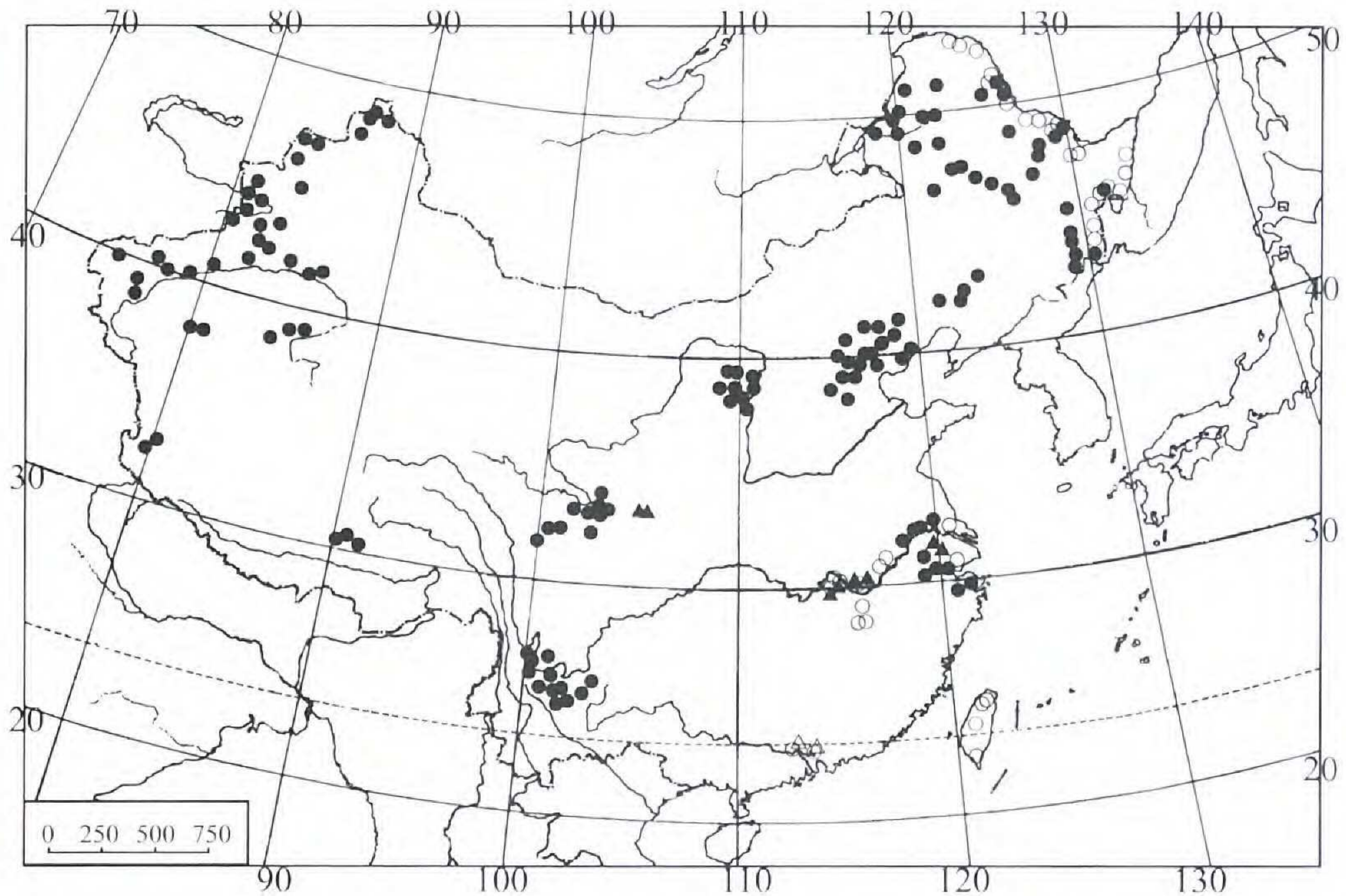


Figure 2. Distribution of Temperate *Myriophyllum* in China. *M. verticillatum* (●), *M. ussuriense* (○), *M. alterniflorum* (▲), and *M. heterophyllum*, naturalized (△).

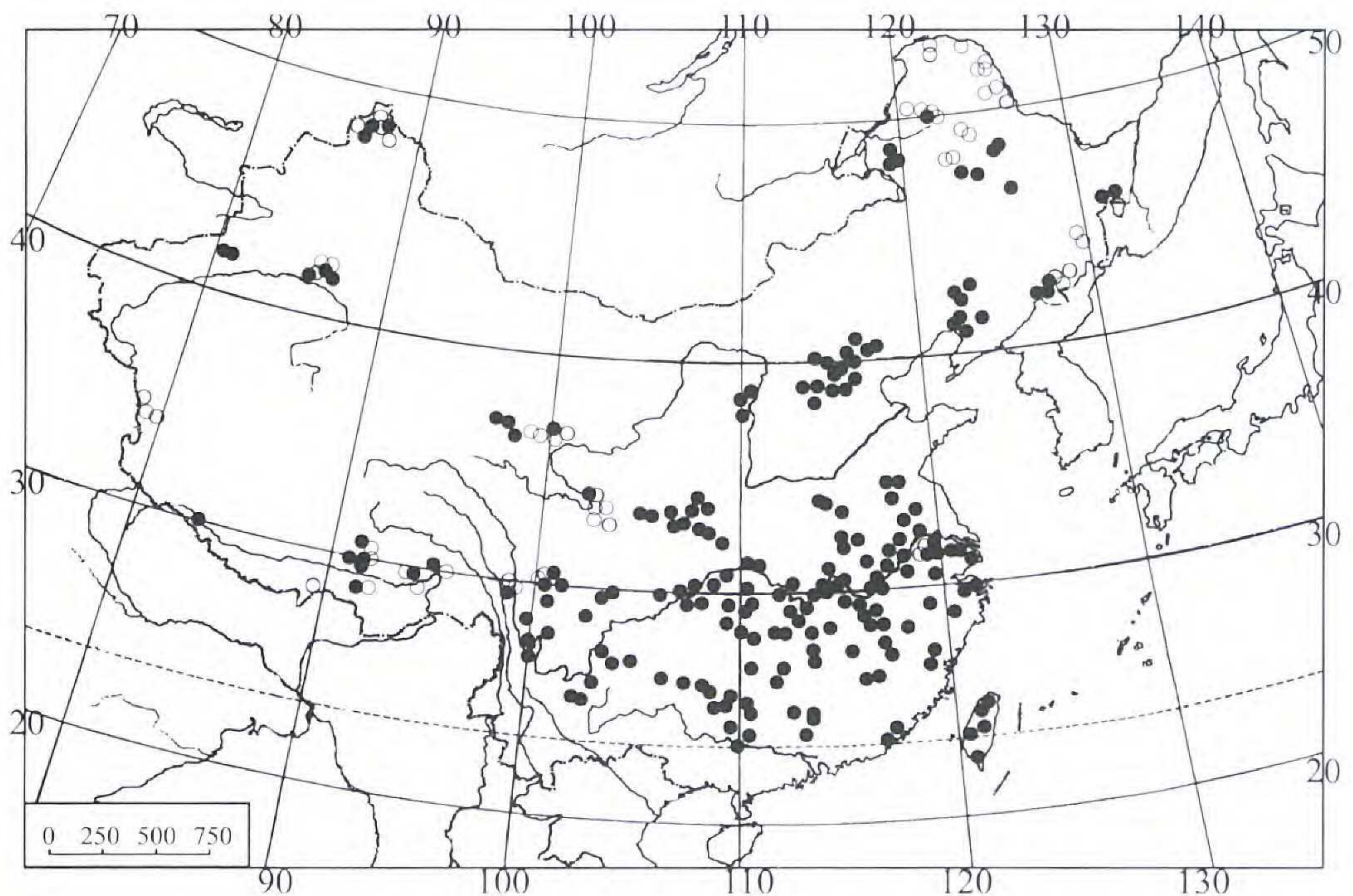


Figure 3. Distribution of the widespread species, *Myriophyllum spicatum* (●), and its allied species, *M. sibiricum* (○). Both species have North Temperate affinities in China.

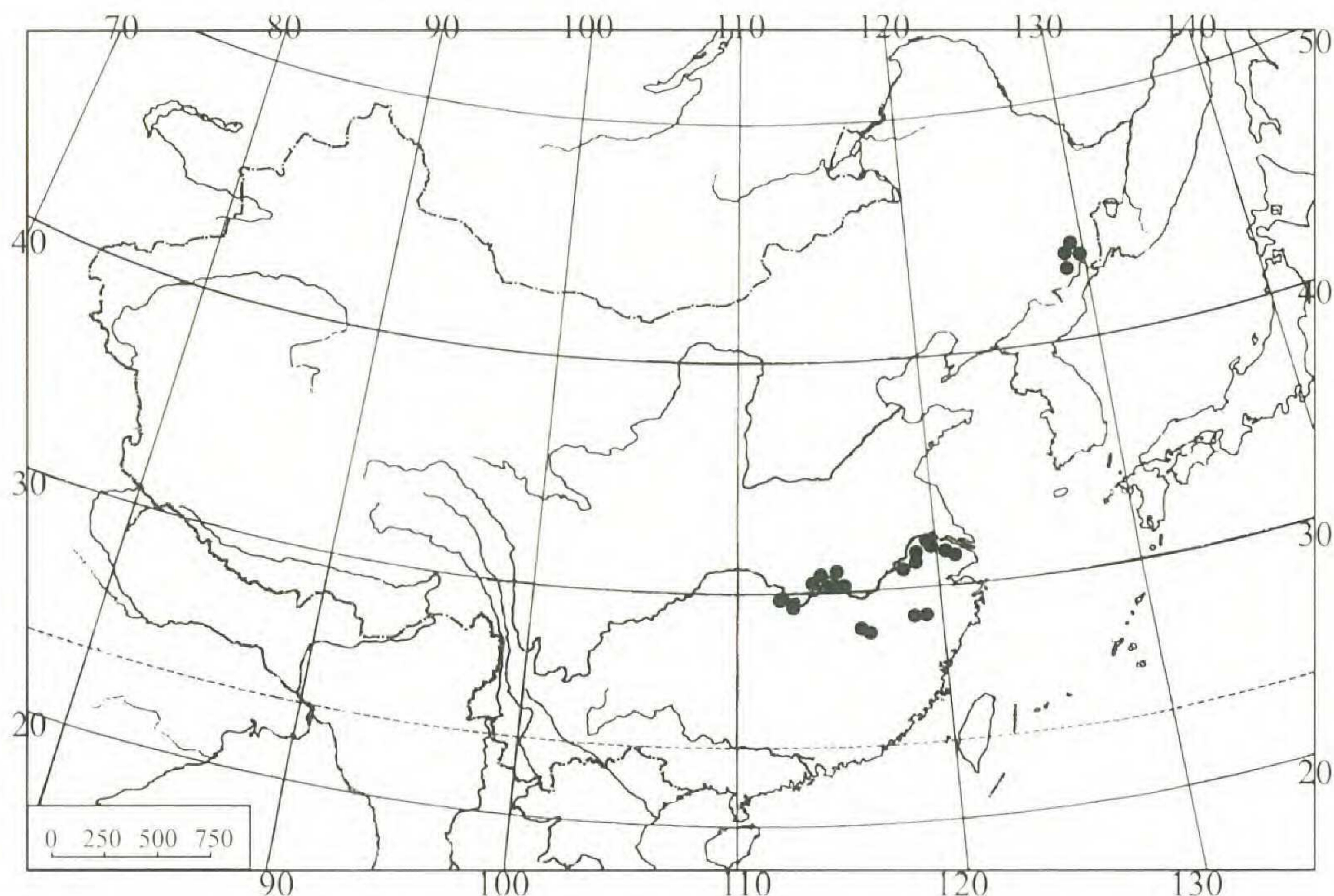


Figure 4. Distribution of East Asian endemic, *Myriophyllum oguraense* (●), in China.

rum, *M. sibiricum*, *M. spicatum*, and *M. verticillatum*; and 4) East Asia endemics (Figure 4), *M. oguraense*. Thus, *Myriophyllum* is found in four major regions of China, and the distribution of Chinese *Myriophyllum* consists of North Temperate, Old World Tropical, and East Asia endemic elements.

The species exhibiting strong tropical affinities and having an Old World Tropics distribution are on the northern borders of their geographical ranges. Of them, *Myriophyllum dicoccum* occurs in Tropical Asia and Tropical Australasia, while *M. tetrandrum* and *M. tuberculatum* occur in Tropical Asia (Indo-Malesia).

The remaining six species are of strong warm/cool temperate affinities that belong to Old World Temperate, Temperate Asian, and East Asia distributions. Of the six, *Myriophyllum ussuriense*, has an Old World Temperate distribution and occurs in Temperate Asia, and *M. oguraense* is an endemic species to East Asia and has a Sino-Japanese disjunct distribution. The others are confined to a North Temperate distribution. Among them, *M. spicatum* and *M. verticillatum* are almost widespread in the temperate regions of the northern hemisphere and have much wider geographical distributions than the others. The species *M. sibiricum* is confined

to cold temperate regions and *M. alterniflorum* to the boreal and temperate zones of the northern hemisphere.

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LITERATURE CITED

- AIKEN, S. G. 1978. Pollen morphology in the genus *Myriophyllum* (Haloragaceae). *Canad. J. Bot.* 56: 976–982.
- . 1979. North American species of *Myriophyllum* (Haloragaceae). Ph.D. dissertation, Univ. Minnesota, Minneapolis, MN.
- . 1981. An experiment relating vegetative morphology of *Myriophyllum alterniflorum* DC. (Haloragaceae) to growth substrate. *Aquat. Bot.* 10: 383–388.
- AND A. CRONQUIST. 1988. Lectotypification of *Myriophyllum sibiricum* Komarov (Haloragaceae). *Taxon* 37: 958–959.
- AND J. MCNEILL. 1980. The discovery of *Myriophyllum exalbescens* Fernald (Haloragaceae) in Europe and the typification of *M. spicatum* L. and *M. verticillatum* L. *Bot. J. Linn. Soc.* 80: 213–222.
- , P. R. NEWROTH, AND I. WILE. 1979. Biology of Canadian weeds. *Canad. J. Pl. Sci.* 59: 201–215.
- AND K. F. WALZ. 1979. Turions of *Myriophyllum exalbescens*. *Aquat. Bot.* 6: 357–363.
- ASTON, H. I. 1977. *Aquatic Plants of Australia*. Melbourne Univ. Press, Melbourne, Australia.
- CESKA, A. AND O. CESKA. 1986. Notes on *Myriophyllum* (Haloragaceae) in the Far East: The identity of *Myriophyllum sibiricum* Komarov. *Taxon* 35: 95–100.
- CESKA, O. 1977. Studies in aquatic macrophytes. Part XVII: Phytochemical differentiation of *Myriophyllum* taxa collected in British Columbia. Water Investigation Branch, Ministry of Environment, Victoria, BC, Canada.
- CHUN, W. Y. 1964. *Flora of Hainan*. Science Press, Beijing.
- COOK, C. D. K. 1996. *Aquatic and Wetland Plants of India*. Oxford Univ. Press, Oxford, U.K.
- CORRELL, D. S. AND H. B. CORRELL. 1975. *Aquatic and Wetland Plants of Southwestern United States*. Stanford Univ. Press, Stanford, CA.

- CROW, G. E. 1993. Species diversity in aquatic angiosperms: Latitudinal patterns. *Aquat. Bot.* 44: 229–258.
- AND C. B. HELLQUIST. 1983. Aquatic vascular plants of New England: Part 6. Trapaceae, Haloragaceae, Hippuridaceae. Bull. 524, New Hampshire Agric. Exp. Station, Durham, NH.
- DIAO, Z. S. 1990. *The Wild Aquatic Herbs of China*. Chongqing Press, Chongqing, China.
- FAEGRI, K. 1982. The *Myriophyllum spicatum* group in North Europe. *Taxon* 31: 467–471.
- FU, L. K. 1993. *Index Herbariorum Sinicorum*. China Science and Technology Press, Beijing.
- GOOD, R. 1974. *The Geography of the Flowering Plants*, 4th ed. Longman Inc., London and New York.
- HARA, H. 1954. *Enumeratio Spermatophytarum Japonicarum*, Vol. 3. Iwanami Shoten, Tokyo. [p. 275]
- HARRIS, S. A., S. C. MABERLY, AND R. J. ABBOTT. 1992. Genetic variation within and between populations of *Myriophyllum alterniflorum* DC. *Aquat. Bot.* 44: 1–21.
- HOW, F. C., ed. 1956. *Flora of Guangzhou*. Science Press, Beijing.
- HUANG, T. C. 1977. Haloragaceae, p. 903. *In*: H. L. Li, et al., eds., *Flora of Taiwan*, Vol. 3. Epoch Publishing Co., Ltd., Taipei, China.
- IWATSUKI, K. 1992. *Endangered Fifty Plants of Japan*. Tukiiji-Shokan, Tokyo. [In Japanese]
- KADONO, Y. 1994. *Aquatic Plants of Japan*. Bun'ichi-sogo-Shuppan, Tokyo. [In Japanese]
- LI, Z. Y. AND C. F. HSIEH. 1996. New materials of the *Myriophyllum* L. (Haloragaceae) in Taiwan. *Taiwania* 41: 322–328.
- LÖVE, A. 1961. Some notes on *Myriophyllum spicatum*. *Rhodora* 63: 139–145.
- MATHEWES, R. W. 1978. Pollen morphology of some western Canadian *Myriophyllum* species in relation to taxonomy. *Canad. J. Bot.* 56: 1372–1380.
- MAXIMOWICZ, C. J. 1873. Diagnoses breves plantarum novarum japoniae et mandshuriae. *Bull. Acad. Imp. Sci. Saint-Pétersbourg* 19: 182.
- MEIJDEN, R. VAN DER. 1969. An annotated key to the South East Asiatic, Malesian, Mascarene and African species of *Myriophyllum* (Haloragaceae). *Blumea* 17: 303–311.
- AND N. CASPERS. 1971. *Myriophyllum*. *In*: C. G. G. J. van Steenis, ed., *Fl. Malesiana*. Ser. 1, Vol. 7(1): 248–259.
- MIKI, S. 1934. On fresh water plants new to Japan. *Bot. Mag. Tokyo* 48: 335–336.
- . 1937. *The Water Phanerogams in Japan, with Special Reference to Prov. Yamashiro. Report on the Historical Remains, Scenic Places and Natural Monuments in Kyoto Prefecture* 18: 1–127. [In Japanese]
- MUENSCHER, W. C. 1944. *Aquatic Plants of the United States*. Comstock Publ. Co., New York.
- OHWI, J. 1953. *Flora of Japan*. Shibundo Co., Ltd., Publishers, Tokyo. [p. 826]

- . 1975. Flora of Japan, new ed. Shibundo Co., Ltd., Publishers, Tokyo. [p. 958]
- AND M. KITAGAWA. 1992. New Flora of Japan. Shibundo Co., Ltd., Publishers, Tokyo. [p. 1098]
- ORCHARD, A. E. 1979. *Myriophyllum* (Haloragaceae) in Australasia. I. New Zealand: A revision of the genus and a synopsis of the family. *Brunonia* 2: 247–287.
- . 1990. Haloragaceae, pp. 5–85. *In*: A. S. George, ed., Flora of Australia, Vol. 18. Australian Govt. Publ. Service, Canberra.
- PATTEN, B. C., JR. 1954. The status of some American species of *Myriophyllum* as revealed by the discovery of intergrade material between *M. exalbescens* Fern. and *M. spicatum* L. in New Jersey. *Rhodora* 56: 213–225.
- PRAGLOWSKI, J. 1970. The pollen morphology of the Haloragaceae with reference to taxonomy. *Grana* 10: 159–239.
- PRESTON, C. D. AND J. M. CROFT. 1997. Aquatic Plants in Britain and Ireland. Harley Books, B. H. & A. Harley Ltd., Colchester, U.K.
- PUGSLEY, H. W. 1938. A new variety of *Myriophyllum alterniflorum* DC. *J. Bot.* 76: 51–53.
- REGEL, E. 1861. Tentamen Florae Ussuriensis, oder Versuch einer Flora des Ussuri-Gebietes. Nach den von Herrn R. Maack gesammelten Pflanzen bearbeitet. *Mém. Acad. Imp. Sci. Saint-Pétersburg* VII. Ser. 4(4): 60.
- TAKHTAJAN, A. L. 1978. Floristicheskoye oblasty Zemli (Floristic Regions of the World). Nauka, Leningrad. [In Russian]
- WAN, W. H. 2000. Haloragaceae, pp. 135–140. *In*: C. J. Chen, ed., Flora Reipublicae Popularis Sinicae, Vol. 53. Science Press, Beijing.
- WANG, N. Z., F. S. ZHANG, H. R. HUANG, and F. L. Ma. 1983. The Illustrated Flora of Aquatic Vascular Plants of China. Hubei People's Press, Wuhan, China.
- WEBER, J. A. AND L. D. NOODEN. 1974. Turion formation and germination in *Myriophyllum verticillatum*: Phenology and its interpretation. *Michigan Bot.* 13: 151–158.
- YAN, S. Z. 1983. The illustrated flora of higher aquatic plants of China. Chinese Academic Press, Beijing.
- YU, D. 1992. Aquatic plants of Northeast China. Unpubl. Ph.D. dissertation, Northeast Forestry Univ., Harbin, China.